Towards Understanding Information Architecture: A Distributed Cognition Study of an IT Community of Practice.

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Abstract

Intranets can play significant roles in medium to large organisations. They provide the means for people to communicate and traverse through information spaces, independently of geographical and/or temporal constraints. To date, the term Information Architecture (IA) has been adopted by technology designers to describe both structure and the process of organising information. This paper presents a study of IA as situated in intranet use within a higher-education organisation. The use of ethnographically-informed methods combined with a distributed cognition analytic framework provides an opportunity to extend existing conceptions of IA as it is realised and represented in daily work activities.

Keywords

Information architecture, intranets, information spaces, communities of practice, ethnography, distributed cognition, HCI.

INTRODUCTION

The term *Information Architecture* (IA) is due for reappraisal. IA appears to be everywhere in information spaces; yet the term IA has been limited to a few uses. *Information space* or its predecessor *cyberspace* has been used increasingly to delineate between the physical and virtual environment in which we exist (Dodge and Kitchen 2002). However, virtual or *information* space is a practical way to associate our internal and distributed cognitive processes with the actions we undertake in the real world. Thus, information spaces are not unique to technologies such as internets or intranets. What *is* unique are the ways in which people interact with technology and how that work is shaped by that interaction (Suchman and Trigg 1991).

The main purpose of this research is the development of tools, processes and theoretical perspectives that aim to extend conceptions of information architecture as it is lived, rather than as it is designed. It is hoped that this research can inform the growing body of socio-technical literature relating to information and interaction design practice. The ultimate aim is to provide empirical findings that can assist Human-Computer Interaction (HCI) professionals in the design, development and management of information and communication technologies (ICTs). Of particular interest in this paper are intranets.

For the design of any technology for human use, the assumption is the recognition that all human action is embodied, situated and social (Suchman 1987; Robertson 2004). Thus, understanding actual human practice is central to this research. This is reflected in the design of the ethnographic study and in the interdisciplinary approaches, techniques and methodologies presented in this paper.

Distributed cognition is a school of thinking that builds upon and extends the ideas of cognition that have dominated cognitive science, psychology and HCI (Preece, Rogers, Sharp, Benyon, Holland and Carey 1994). Cognition, it is argued, can be considered as a broader series of processes that are external to individual human information processing and perception as defined by information possessing theories from cognitive science (Hutchins, 1995). The act of cognition is one that requires the distribution of cognitive processes across human and non-human agents, one that is not possible if attempted by a human or non-human agent in isolation. Human cognitive frameworks are relevant to HCI because they provide tools for designers to think with and the theoretical foundation for usability design principles and heuristics (Preece et al. 1994, Preece, Rogers and Sharp 2002).

A recent study of information architects' work practice in Australia discovered that fewer IAs exploited research literature to inform their design processes (Robertson, Hewlett, Harvey and Edwards 2003). This was particularly the case for those practitioners with less than 5 years relevant industry experience. The study highlighted the need for more empirical work to be done to support the professional development of those new to the field, in terms

of educational opportunities and access to relevant literature: this research endeavours to address some of those perceived needs.

The paper begins with a brief discussion of communities of practice, followed by a summary of the conceptions of information architecture as they relate to web design. An overview of the main study from which this paper reports on one community activity is then presented, followed by a description of the ethnographic techniques across the entire study that contribute to the analysis. The analysis of one selected instance of intranet use demonstrates how a distributed cognition framework can be used to explain the core dimensions of IA as a situated and distributed activity between humans and artefacts. The paper concludes with a discussion of the findings and imperatives for HCI research and practice to extend existing conceptions of IA.

BACKGROUND

This study recognises that work occurs within communities of practice, that is, groups of people collaborating and engaging in shared activities in order to get work done (Jordan 1994). These communities arise out of work requirements in organisations from social interactions and in formal and informal settings. The value of understanding intranet use from a community of practice perspective is that we can understand the ways in which information transmission, transformation to meaning, and then organisational knowledge are shaped and then distributed throughout (Wenger 1999).

There is a growing body of technical and commercial writing, listservs and websites dedicated to discussing the theory and practice of Information Architecture for digital media design (web, mobile and other interactive devices) (e.g. Morrogh 2003, Robertson et al. 2003). Irrespective of the diversity of theoretical positions contributed to these discussion fora, two dimensions that relate to information architecture theory and practice seem to be evident, namely, *organisation* and *navigation* (e.g. Rosenfeld and Morville 1998, 2002, Garret, 2002).

An underlying principle common to discussions or literature concerning web-based IA is that of *organisation*. One need only refer to the influential writings of Wurman (1991), who asserts that *the ways of organising are finite* (p. 59) and then forward to current discourse, as *evangelised* by practicing Information Architects (Morrogh 2003), to observe that the organisation constructs of *category*, *time*, *location*, *alphabet* and *continuum*, form the basis of web-based information design. Research has shown that these organisation modes are used by humans to define human activity. It is in our nature, it seems, to want to sort things out (e.g. Bowker and Star 1999).

Navigation or *Wayfinding* are terms used to describe the cognitive and behavioural ability to reach a desired physical destination (Passini 1999, p.154). In its simplest form, wayfinding is concerned with orientation, route decision, route monitoring, and destination recognition processes (Downs and Stea 1974). This term has often been used interchangeably with *navigation*. Recent literature has been critical of the common conceptions of wayfinding and navigation behaviours as the means to describe the activities of people in information spaces. Benyon (2001) argues that these processes are based on earlier internal cognitive processing models, failing to acknowledge the social dimensions of navigation. It can be argued that just as is the case with the expansion of cognitive theories to include the socially distributed nature of cognitive processes, so too is the case with way-finding/navigation. The more recent discussions of cognition (Hutchins 1995) stress the situated and shared nature of activity. If we include the concepts of wayfinding/navigation, the cognitive process find a way to orient, monitor, decide or recognise actions within an information space, does not occur entirely within an individual. Instead, these processes are also distributed across other human and non-human agents.

OVERVIEW OF STUDY

A major field study took place over a period of four months. It included unstructured interviews, ethno-experimental enquiry, web activity log generation and video observation.

The study originally concerned the use of an intranet's information architecture from a usability point of view. The more the organisation and the various communities that comprised it were studied, the more noticeably interesting each community became in its own right. Each community had differing conceptions about, and perceptions of, the organisation of the information available via the intranet.

Just as there are many communities of practice within any given organisation, so too are the potential settings for a single study. The research was in situ for the preliminary studies of the setting. It was determined that there were several major social/organisational communities of practice that were present, including: Academics, Administration (Admin), Students, and Technical Team. The specific setting for the event under observation was within the Admin group, a small sub-community within the FICT group of the university.

Admin specialises in facilitating students' progress through their studies at university, from initial admission to graduation, primarily through Administrative activities relating to initial enrolments, re-enrolments and variation of programs, academic progress, discipline, exclusion & related appeals, formal examinations conduct and graduation. These activities occur as required for the entire student population enrolled for formal study at FICT, approximating 3,000 students per academic semester.

DATA COLLECTION AND METHOD

A grounded theory approach was adopted for data collection. The techniques that were chosen also crossed-over with ethnographic methods. The grounded theory approach, as espoused by Glaser (1992), placed emphasis on understanding the issue of concern for the participant and how this, in turn, can be categorised from the perspective of the incident under investigation. Brief descriptions of each method are presented in the same order as they occurred naturally across the overall study as follows:

Unstructured Interviews

The initial phase of data collection involved the selection of people across the various communities of practice that exist within FICT. Discussions were held with five participants across the four-month period of the data collection phase. The decision not to plan questions in any great detail was deliberate: the findings were to be grounded in the data. In order to partially accomplish this aim a discussion environment where the issues and concerns of those within the community were expressed from their perspective was encouraged. It was also advantageous to allow the informal interview to follow the direction that was relevant to the participant. The initial question for each participant was: "What do you do with the FICT intranet?"

Ethno-experimental enquiry

The term *ethno experimental* has been used in distributed cognition studies to describe the intentional action made by a participant-observer within the research setting in order to see what change results from that action (e.g. Hollans, Hutchins and Kirsch. 2000). This type of enquiry should not be considered as experimental in the positivist sense of the word: the field setting does not provide control measures but the researcher must have an acute awareness of the change brought about by their particular activities and how these observed changes can further the study in general (Hutchins and Klausen 1996, Marshall 1999). Similarities can be drawn between this and action research, in that there is direct involvements by participants. However, the distinguishing feature of ethno-experimentation is not to solve or test a particular hypotheses for interaction between members of the FICT community and the intranet Instead, this experimental method was used to determine the kinds of users and their virtual navigation patterns according to how the Technical group in FICT defined 'users' and 'navigation'.

Web Log Generation

Another part of the data collection for the main study was the observation of actual use of the intranet in people's work activities. The outcomes of the web log 'ethno-experiment' could be applied to the analysis phase on three levels:

- The web activity log generation script – used for identifying large-scale patterns of web use;
- The interpretation of the research agenda by the Technical group – used in their development of an artefact-producing tool for statistical analysis and computer applications; and,
- The activity data - provided another perspective on use and assist in the triangulation process of the study.

Video Observation

On the basis of an earlier interview, Gina, an Administrative officer of the Admin group, agreed to participate in the video-taping/observation of her work, which at the time of the observation, largely consisted of activities related to the electronic changing of enrolment for students (referred to as ECSE).

Two digital cameras were placed at either end of her work station, with the intent of capturing as much of her work as possible, but with the least intrusion or obstruction to her work. As an additional measure the cameras were placed in position on the previous day, without recording. This was designed to make Gina feel more comfortable with additional objects in her working space, as well as be able to make recommendations for the arrangement of the cameras for the recording session itself. A total of four hours of Gina's work was recorded, two hours per day, over two consecutive days. The video data was then edited to remove any confidential or private information, or images/sounds of other Admin staff who did not wish to be 'caught on film'.

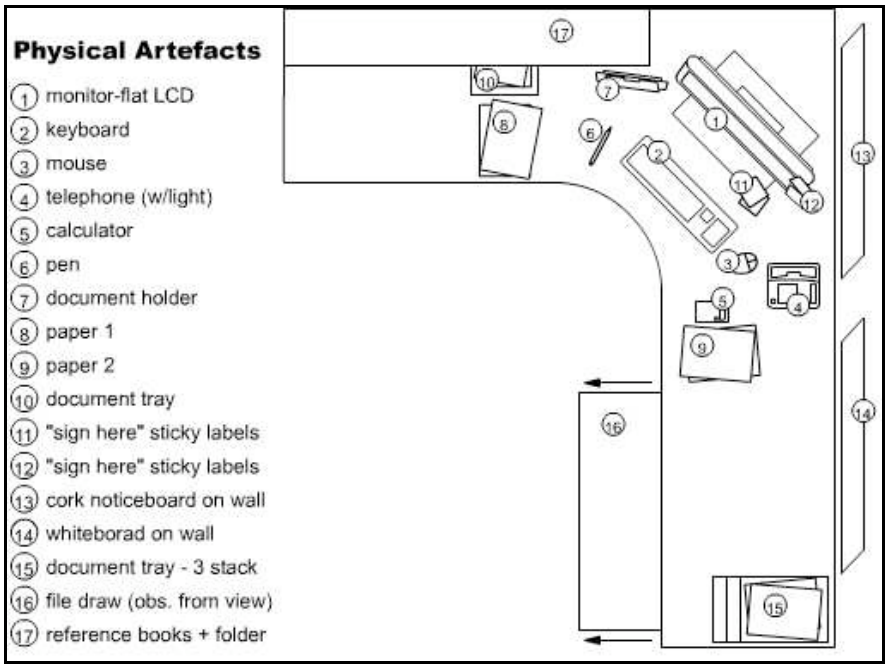

Figure 1: Gina's physical workspace and identification of physical artefacts

ANALYSIS

The major focus of the main study was the observable behaviours of both people and the technological artefacts they used to complete activities. The following details provide one example of the analysis of a sequence of events for a common activity by one of the community members of Admin; adjusting the subject enrolment for students in FICT. A snapshot of the particular activity was observed and analysed using a distributed cognition framework. The underlying principles of distributed cognition (as proposed by Hollans et al. 2000) can be noted throughout Gina's activity:

- Social – the activity involved several members from a number of sub-communities within FICT (Admin and Student);
- Processes - the activity required both internal (individual) and external (environmental) processes in order for it to occur; and,
- Temporal - the processes that occurred were such that the electronic request lodged by a student at any time was then the focus for activities with the intranet and other external processes by Admin to complete the updating of the student records system.

Applying distributed cognition to ECSE

A distributed cognition analytic framework focuses on the observed actions and functions of humans and artefacts as a holistic system. It is possible to define the portion of the system to be analysed, based on these observed functions. A functional unit exposes the information about the activity, its resources and organisation. The resulting unit is referred to as the 'unit of analysis' (Hutchins 1995). A functional human system such as *electronic change of student enrolment* (ECSE) has the quality that many of the system properties are directly observable.

In the specific analysis for this paper, the cognitive system's purpose is to update student enrolment status in the student records database (SRDB). The student's *electronic change of student enrolment* details can be seen as the input to this system, and their change of enrolment details is a representational state travelling via the digital media of the intranet to Gina. For each variation of program the unit of consideration may vary. Figure 2 shows how the system was initially defined to include the student, Gina, intranet and other material resources available to Gina for the ECSE process.

While her use of the intranet is an indicator of where the process is occurring, it does not completely define the limits of the activity. In general, the functional system is observed to be bounded by physical, resource, and temporal limits. At another level, an examination of Gina's workspace shows there are many other available resources. Depending on the type of enrolment variation, Gina can use a variety of on-line resources. In addition

there are a myriad of yellow post-it notes, printed lists and other print media all within arms reach: telephone numbers and course codes are tacked onto her right wall or on noticeboards. More regularly changing information is displayed on the right wall, on a whiteboard behind her. Her monitor has a separate window display for each software application available to her (word processing, spreadsheets, email, web browser, SRDB, instant messenger). The virtual resources that Gina has at her disposal are represented as digital artefacts in Figure 2. They are:

- 1d – Instant Messenger (pop-up window)
- 2d – SRDB interface
- 2dp – SRDB database (not visible to Gina)
- 3d – The intranet (including changes of 'page', for example 3d1, 3d2, 3d3, when Gina is accessing information for the ECSE)
- 4d – Email application (the main screen with a list of email messages (4d1 denotes a single email in a separate window)
- 5d – A window displaying a list of files located on her local computer hard disk
- 6d – The computer desktop screen

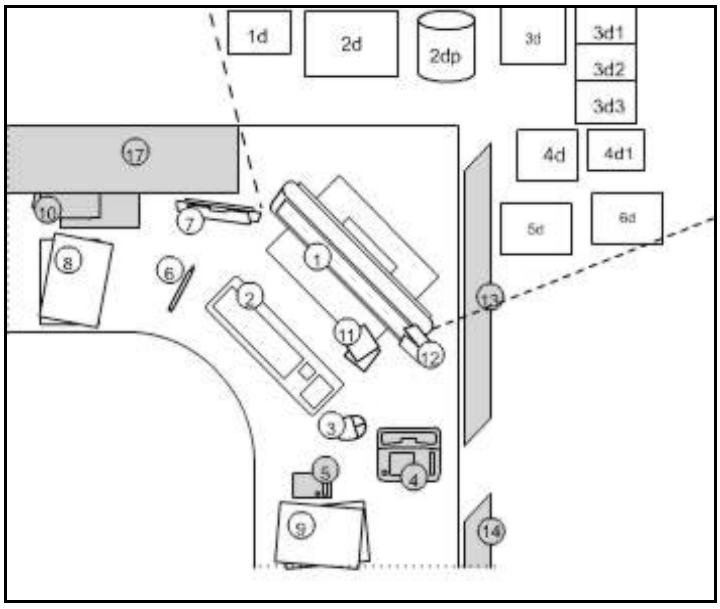

Figure2: The Unit of Analysis – Changing student enrolment record

One of the challenges of analysing the ECSE is that there was an absence of spoken information that accompanied the activities. None was required for Gina to undertake her activities. That is not to say that Gina did not communicate with others during the process, quite the opposite, in fact. One of the interesting features of Gina's work activities was that she was in constant contact with other members in the office via an instant messenger program. The interface was prefigured to come into view (*pop-up*) whenever a new message was sent to her. From an observer's point of view this was intriguing – when physically present the office seemed quiet, just the incidental sounds from typing, phones ringing, the Admin customer desk staff talking to students at the front. However, if the amount of instant messages were to be made audible, the amount of talking and cross-conversation in the office would be overwhelming. The expression *the silence is deafening* came to mind – the irony of that statement seemed all the more so in this setting.

For this paper, a single instance of the ECSE process was chosen for detailed analysis. Table 1 summarises the observation data that shows the complexity of action and the change of information – from student online request to the confirmation email back to the student confirming the change was successful.

Observing work practice using video data provides a rich, if not complex, interpretation of what is occurring between people and technologies (Suchman and Trigg 1991). The following observation maps out the sequence of Gina using virtual information resources (as shown in Figure 2), and then, changing the ways in which the information is represented by using physical information resources (pen, paper and 'sign-here' sticky labels) to monitor her navigation to specific locations within the intranet and the SRDB in order to reorganise the information for the student's record.

Table 1 is an observation log taken from 27 seconds of video footage from the study. Each artefact is allocated a number in the log. Gina was updating student records. The focus in this instance of interaction is the intranet and the 'changes of representational state', a term used to describe the same artefact with some alteration (for example, a change of screen). In the first 9 seconds, Gina is focusing on a series of emails (4d1) and matching information from a document placed in the document holder (7). She changes her gaze constantly between these artefacts; the SRDB interface (2d) and the monitor itself, where several *sign here* sticky notes are pasted on the right-hand side to the screen. All the while she has her right hand on the two-button mouse (3), clicking the left pointer on the email messages in order to read each one. The capital X on the observation log denotes Gina's visual focus during the event, the lower case x represents physical engagement or fleeting visual glances.

At 10 seconds into the activity, Gina then turns her attention and movement to the intranet. Here, she clicks to select the bookmark on here web browser to access the ECSE entry page. She is reading through the latest enrolment information: the display of information changes (from 3d1 to 3d2). At the same time, Gina clicks her mouse to reveal other screens, namely: a windows browser with file lists (5d) followed by the desktop image (6d)

In the final 10 seconds, Gina's focus is now on two sets of documents: each pertaining to the change of enrolment for particular students. She uses her pen to cross out information, creating a self-check for her progress and to adjust the details on the documents (8 and 9). She finishes writing on each set of documents and signals to herself by removing the *sign here* labels (11 and 12) from the documents, placing them to the right-hand side of the monitor.

Time (seconds) Recording Artefacts & Information States	01	02	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1	x	x	x	x	x	x	x	x	x	x	x	x	x											x	x	x	x
2																											
3	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x										
6																		x	x	x	x	x	x				
7		**X**	**X**	**X**			**X**	**X**	**X**																		
8																		**X**	**X**	**X**							
9																					**X**	**X**					
11																								x	x		
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1d													x	x	**X** 3d1	**X** 3d2	x										
2d	x	x				x	x	x	x																		
3d										**X**	**X**	**X**		**X**	**X**	**X**	**X**										
4d	x	x	**X** 4d1	**X** 4d1	**X** 4d1	**X** 4d1	**X** 4d1	**X** 4d1	**X** 4d1																		
5d																x											
6d																	x										

Table 1: Record of observed interaction between Gina, physical and virtual resources

The lack of physical space in this paper prevents the more longitudinal analysis and discussion of the event. In short, the twenty-seven second snapshot of Gina's work activity is repeated for each ECSE process. This repeated set of actions can last over an entire working day.

FINDINGS

When the temporality is removed from the interactions between Gina, her physical and virtual spaces, we are able to construct a representation of the key processes between all three. However, it is interesting to note the data in

Table 1 shows at 6'53" Gina was able to immediately view the main intranet page for admin staff required for her to continue the ECSE process initiated by the student, without, it appears, any additional actions for accessing the information (searching, monitoring her progress, and so on). Upon closer inspection of the video data, it was apparent that Gina had created a list of bookmarks to the specific intranet pages for reducing the time spent navigating to reach the information. She had, in effect, circumvented the intranet's own navigation structure, in favour of her own. In addition, Gina perceived the input from the student (via the intranet) and then reconstructed the features that were most salient to her needs for the ECSE into information artefacts. The results were a set of physical artefacts that acted as cognitive prompts external to her internal thinking processes.

This leaves us with the core human and non-human agents and artefacts that constitute the functional system for the ECSE (See Figure 3). In effect, the cognitive processes that are observable through actions are distributed. What is also evident is that the information from the intranet itself is a pivotal agent in the interaction between the student (initial input) and Gina (process/final output).

The representation of the ECSE Cognitive System in Figure 3 is but one possible representation of the functional and cognitively distributed system that shows the relationships of inputs and outputs between Gina (A1), a student (S1) submitting the ECSE request through the intranet, and the resources that assist her in changing the organisation and navigation through the information initially brought to her via the FICT intranet. One of these *resources* includes another Admin staff member (A2), whom Gina communicates with via the Instant Messenger artefact (1d)

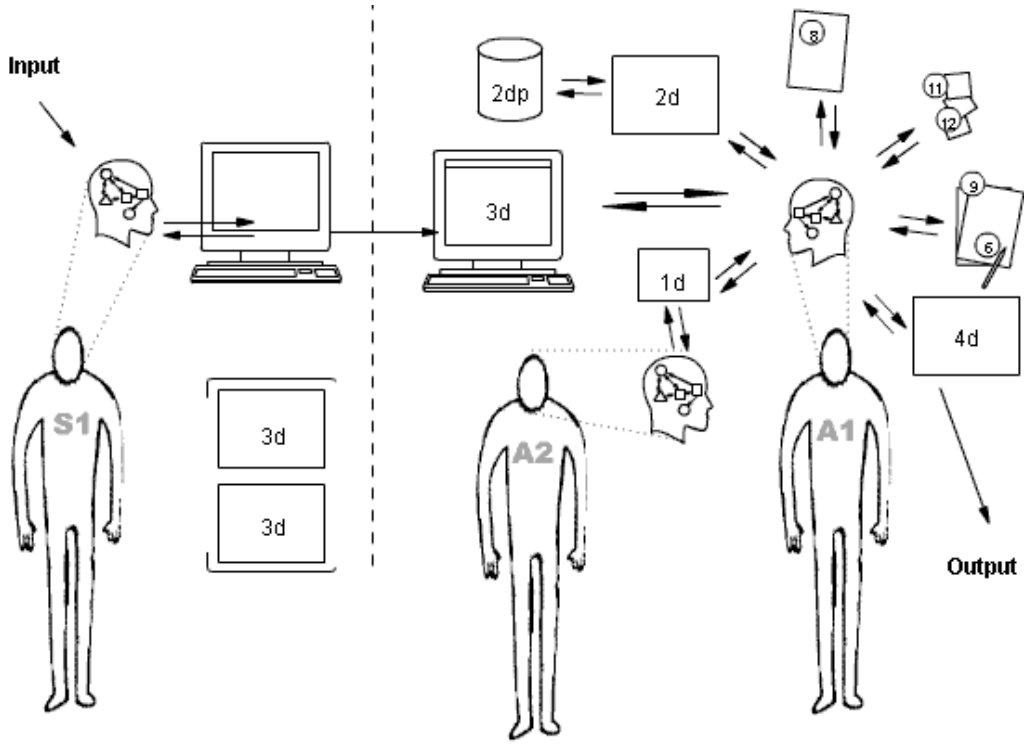

Figure 3: The ECSE Cognitive System

DISCUSSION

The outcomes of this research are of interest not only for HCI practitioners but also for, organisational developers and IT management. These findings were grounded in the lived experiences of the members of the FICT community that also included the researcher as a full participant-observer. As such, interacting with each of the communities of practice within FICT enabled a deeper appreciation of how many work activities, for some of these communities, are reliant upon using the intranet. The findings also demonstrate the importance of *user control* and *customisation* of the total working environment, not just the intranet itself.

In this research, the importance of understanding information architecture comes from an ethnographically-informed approach that is underpinned by a distributed cognition analytical framework. The situated nature of actual work practice needs this type of research if we are to come any closer to understanding the complexity of people interacting within their work communities; the intranet being a crucial agent in these settings.

Using a distributed cognition framework for analysis leads us to reconsider the current conceptions of IA. Overall, the notion of what IA means as a design construct is extended. This was most evident when the focus of the ECSE system was on the information flows between people and work setting artefacts. As a result, this approach diffuses the tension that naturally exists between IA as a *structure* (organisation) and as a *process* (navigation).

The idea that a person determines his or her own IA could be seen as challenging the role of the designer. Does this mean that the need to design fixed organizational schemas and navigation actions is wasted effort on the designer's part? The answer to this is 'No': people will be creative in the use of (digital) tools to suit their needs, regardless of the intended function of the tool by its maker (Pacey 1999).

This study of work practices relating to an IT organisation's intranet broadens the interpretation of the term of *information architecture*. Through a variety of ethnographic methods, it was found that the representational states of information are not fixed, nor are the mechanisms for traversing information and physical spaces which the media inhabits (Bowker 1996).

Post-cognitive theories and socio-technical perspectives of use challenges the conceptual models often employed in HCI design and evaluation. Traditional theories of cognition can no longer be considered adequate for the task of informing design practice. This research has shown that the resulting artefacts (the intranet) do not take into account the dynamic and distributed nature of cognition in work settings. The use of a distributed cognition analytic framework for an instance of use demonstrated that the information architecture of an intranet was not pre-determined. Instead, it was the situated actions between humans and artefacts that resulted in a new IA that was appropriate for the needs of the work activity itself.

REFERENCES

Benyon, D. (2001) The new HCI? Navigation of information space, *Knowledge-Based Systems*, 14, 425-430.

Bowker, G.C. (1996) The History of Information Infrastructures: The Case Of The International Classification of Diseases, *Information Processing & Management, 32(1)*, 49-61.

Bowker, G.C. and Star, S.L. (1999) *Sorting Things Out: Classification and Its Consequences*, MIT Press, Cambridge, Mass.

Dodge, M. and Kitchen, R. (2000) *Mapping Cyberspace*, Routledge, Florence, KY.

Downs, R. and Stea, D. (1974) "Cognitive Maps and Spatial Behavior", in R. Downs and D. Stea (eds.) *Image and environment: cognitive mapping and spatial behavior*, Edward Arnold, London, 8-26.

Garret, J.J. (2002) *The Elements of User Experience*, New Riders, Sebastopol.

Glaser, B. (1992) *Basics of grounded theory analysis*, Sociology Press, Mill Valley, CA.

Hollans, J., Hutchins, E. and Kirsch, D. (2000) Distributed Cognition: Toward a New Foundation for Human-Computer Interaction Research, *ACM Transactions on Computer-Human Interaction, 7(2), June 2000*, 174-196.

Hutchins, E.L and Klausen, T. (1996) "Distributed Cognition in an Airline Cockpit" in D. Middleton and Y. Engeström (eds.) *Communication and Cognition at Work*, Cambridge University Press, New York, 15-34.

Hutchins, E.L. (1995) *Cognition in the Wild*, MIT Press, Cambridge, MA.

Jordan, B. (1994) *Ethnographic Workplace Studies and Computer Supported Cooperative Work*. Institute for Research on Learning, Report No. IRL94-0026, June 1994, CA.

Marshall, J (1999) Living life as inquiry, *Journal of Systemic Practice and Action Research, 12(2)*, April 1999, 155-171.

Morrogh, E. (2003*). Information Architecture: An Emerging 21st Century Profession*, Prentice Hall, Upper Saddle River, NJ.

Pacey, A. (1999) *Meaning in Technology*, MIT Press, Cambridge, MA.

Passini, R. (1992) *Wayfinding in Architecture*, Van Nostrand Rheinhold, New York.

Preece, J., Rogers, Y., Sharp, H., Benyon, D., Holland, S. and Carey, T. (1994) *Human-Computer Interaction*, Addison-Wesley, Harlow, England.

Preece, J., Rogers, Y. and Sharp, H. (2002) *Interaction Design: Beyond human-computer interaction*. Wiley, New York.

Robertson, T. (2004) 'About Us', *Interaction Design and Work Practice Laboratory Website,* viewed 15th August, 2004, <http://research.it.uts.edu.au/idwop/about.html>.

Robertson, T., Hewlett, C., Harvey, S. and Edwards, J. (2003) A Role With No Edges: The Work Practices of Information Architects in *Proceedings of HCI International 2003, Crete, Greece*.

Rosenfeld, L. and Morville, P. (1998) *Information Architecture for the World Wide Web: Designing Large-Scale Web Sites 1st Edn*, O'Reilly, Sepastopol.

Rosenfeld, L. and Morville, P. (2002) *Information Architecture for the World Wide Web: Designing Large-Scale Web Sites 2nd Edn*, O'Reilly, Sepastopol.

Suchman, L. (1987) *Plans and Situated Actions: The Problem of Human-machine Communication*, Cambridge University Press, Cambridge.

Suchman, L. and Trigg, R. (1991) "Understanding Practice: Video as a Medium for Reflection and Design", in J. Greenbaum and M. Kyng (eds.) *Design at Work: Cooperative Design of Computer Systems*, Lawrence Erlbaum, Hillsdale, N.J.

Wenger, E. (1999) *Communities of practice: learning, meaning, and identity.* Cambridge University Press, New York.

Wurman, R.S. (1989) *Information Anxiety: What to Do When Information Doesn't Tell You What You Need to Know*, Pan, London.

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